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	Prepared by(s) Paul Dizon	Supersedes LAT-PS-01347-00
	Subsystem/Office Calorimeter Subsystem	
Document Title **CAL Module Thermal-Vacuum Test Procedure**		

Gamma-ray Large Area Space Telescope (GLAST)

Large Area Telescope (LAT)

Calorimeter Module Thermal-Vacuum Test Procedure

DOCUMENT APPROVAL

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CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
-00	03 Dec 2002	Initial Draft
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1 INTRODUCTION

1.1 PURPOSE

The purpose of this test is to provide a vacuum environment where system functional testing, muon collection and thermal balance can be characterized at thermal extremes. This procedure details the sequence and methods to be followed in performing the module level thermal vacuum testing of the GLAST Calorimeter (CAL) Module Engineering Module (EM) in accordance with the LAT Calorimeter Verification & Environmental Test Plan, LAT-SS-01345. The test results will be presented in a separate test report, GLAST CAL Module EM Thermal-Vacuum Test Report (LAT-RP-xxxTBD), upon completion of the test.

1.2 OBJECTIVE

The objective of this test is to verify the survival and performance of the GLAST CAL Module EM over the qualification temperature ranges of –30 deg C to +50 deg C. The test will include thermal balance characterization as well as electrical functional testing and muon collection.

1.3 VERIFICATION

This test satisfies the requirements for verification of the GLAST CAL Module EM as specified in the LAT Calorimeter Verification & Environmental Test Plan, LAT-SS-01345. This test will verify workmanship of the system and the functionality under temperature extremes.

2 APPLICABLE SPECIFICATIONS

Documents required to perform this test will accompany the test article, including the As-Built Configuration List (ABCL) and traveler control sheets. The applicable documents cited in this standard are listed in this section only for reference. The specified technical requirements listed in the body of this document takes precedence over the source document is listed in this section.

2.1 GOVERNMENT SPECIFICATIONS

The following specifications, standards and handbooks form a part of this document to extent specified herein.

Number	Title
GEVS-SE	General Environmental Verification Specification for STS & ELV Payloads, Subsystems, and Components

2.2 NON-GOVERNMENT SPECIFICATIONS

Number	Title
LAT-SS-00788	LAT Environmental Specification
LAT-SS-01345	LAT CAL Verification & Environmental Test Plan
N/A	CAL Quality Assurance Plan
N/A	Instrumentation Manuals

2.3 DRAWINGS

Number	Title
GLT-LLR-00-00-B	EM Calorimeter Module, GLAST

2.4 ORDER OF PREFERENCE

In the event of a conflict between this document and the technical guidelines cited in other documents referenced herein, the technical guidelines of this document would take precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3 TEST DECRIPTION

3.1 TEST OBJECTIVE

The objective of this test is to verify the performance of the GLAST CAL Module EM over the qualification temperature ranges.

3.2 TEST METHODOLOGY

This test will be conducted in the North Chamber in the Thermal-Vacuum Laboratory of the Payload Check-Out Facility, Building A-59, of the Naval Research Laboratory, Washington, D.C.

The CAL EM and QM Modules shall be subjected to a thermal vacuum test with thermal cycling to the qualification levels (-30 deg C to +50 deg C). These modules will undergo 12 (twelve) cycles for qualification purposes. Temperature ramp of the crystals shall not exceed 10 deg C per hour. At the hot and cold plateaus, a 8-hour, minimum soak at these temperatures will be demonstrated at the Qual level.

The TVAC test environment is cold-biased by means of a grid test fixture surrounding the test fixture. Heaters on the grid test fixture and test fixture control the temperature ramp and maintain constant test temperatures.

Thermal balance will be characterized during the first cycle at nominal operating and qualification temperature levels. Prior to initiating the test, initial functional testing will take place at ambient temperature and vacuum. At that point, the test will initiate the temperature ramp-up to the hot case.

Tests that will occur in the thermal-vacuum environment are outlined below:

- Electrical functional testing and muon collection will take place during the thermal cycling in a high vacuum environment.
- Turn on shall be performed once at the hot plateau and once at the cold plateau.
- Complete Performance Tests (CPT) shall be performed at each plateau.
- Limited performance tests shall be conducted during thermal transitions in where system failures or intermittent problems are most likely to occur.

The thermal-vacuum test also fulfills the bakeout function as the first “hot” soak since the chamber temperature is elevated to a level in excess of 40° C. TQCM will be used to verify that bake-out is complete.

3.3 TEST ARTICLE DESCRIPTION

The test article is the EM of the GLAST CAL Module (GLT-LLR-00-A) as documented in the as-built configuration list (ABCL). There are no deviations from the flight configuration:

- TEM is attached to the EM CAL Module Base Plate
- TPS is attached to the TEM

The GLAST CAL Module in flight configuration is shown in Figure 3-1.

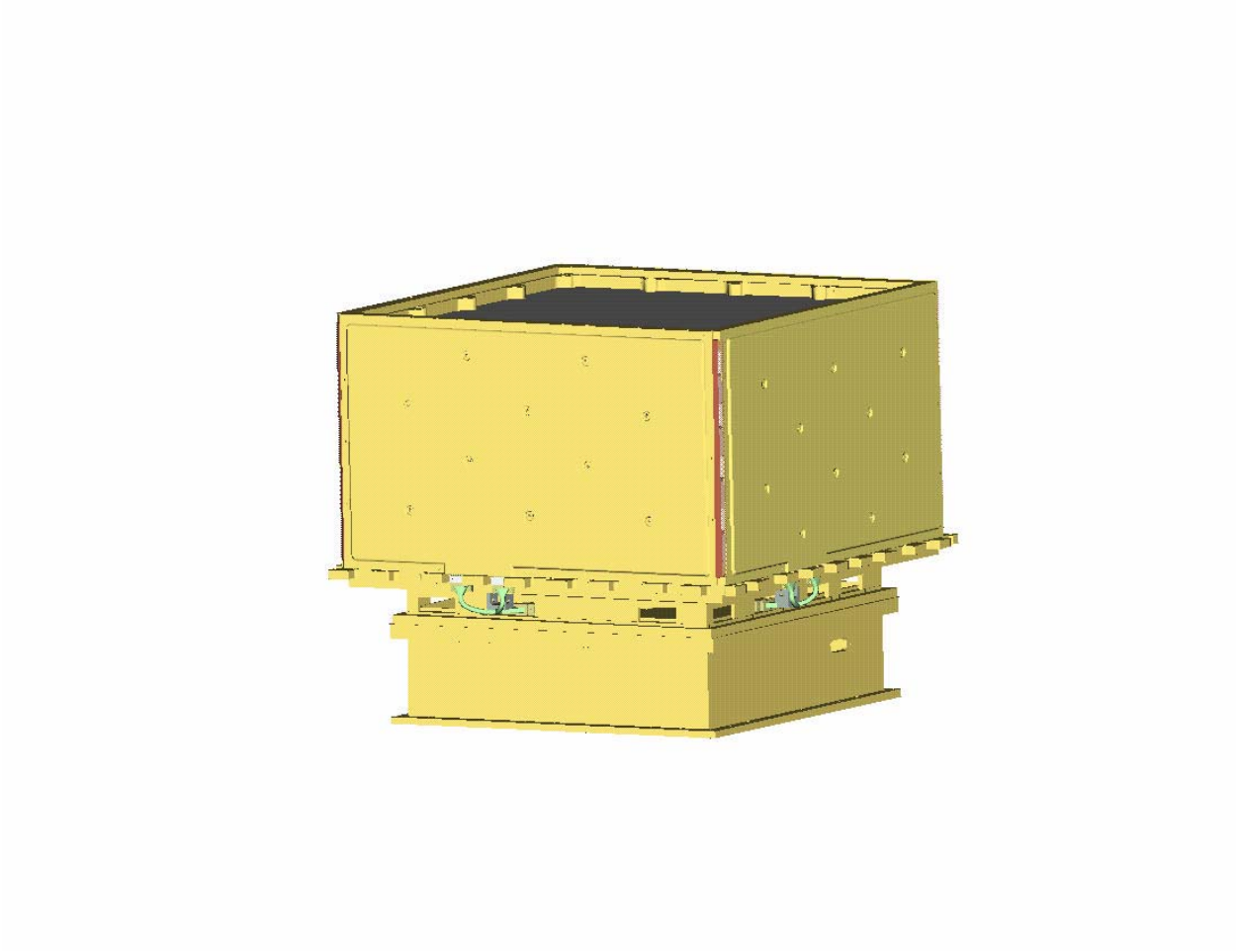


Figure 3-1 – CAL EM in Flight Configuration with TEM/TPS

4 TEST RESPONSIBILITIES

4.1 TEST PERSONNEL

Test personnel are defined below. Responsible points of contact for this test procedure are listed in Table 4-1.

Table 4-1 – Test Personnel

Role	Name	Telephone Number
Project Representative	Eric Grove	202-767-3112
Test Director	Paul Dizon	202-404-7193
Test Conductor, Primary	Mike Van Herpe	202-767-3944
Test Conductor, Electrical Subsystem	Jim Ampe	202-404-1464
Test Conductor, Science Subsystem	Eric Grove	202-767-3112
Instrumentation/Data Support	Mike Van Herpe	202-767-3944
Analysis Support	Oscar Ferreira	33-1-69-33-3187
	Pierre Prat	33-1-69-33-3925
	Peck Sohn	301-902-4098
Quality Assurance Support	Nick Virmani	301-902-4344

4.1.1 Project Representative

The Project Representative represents the GLAST project and will have the responsibility to ensure that no violations of project procedures or CAL handling procedures take place.

4.1.2 Test Director

The Test Director (TD) will have primary responsibility for directing test activities, maintaining the log, documenting the test schedules, coordination of resources, and preparation and close-out of all Problem Reports (PRs). The TD will also have the primary responsibility for all data collection and evaluation during the test for the final test report. The TD will be responsible for coordinating the inputs from the Test Conductors and Quality Assurance representatives, developing the as-run test file, and for executing the as-run test approval sheet. This includes assuring that all PRs have been properly prepared and correctly executed.

4.1.3 Test Conductor

The Test Conductor(s) will be responsible for a specific activity being conducted. The Primary Test Conductor will also be responsible for the entire laboratory, installation and check-out of instrumentation, data acquisition, and data reduction. The other TC(s) will be responsible for executing their specified test procedures. The TC(s) is also responsible for the preparation, operation of test equipment, and the scheduling of daily activities mentioned in the test procedure.

4.1.4 Support Personnel

Support Personnel are responsible for specific activities supporting installation of instrumentation, managing data, and providing real-time data analysis support.

4.2 CONFIGURATION VERIFICATION

Upon completion of the test setup, the Test Director, Test Conductor and Quality Assurance representative must inspect and approve the test configuration and test conditions, prior to the start of the testing and at any key phases of the test.

4.3 TEST DISCREPANCY RESOLUTION

In event of a test discrepancy, which indicates the potential of damage to equipment, a failure of the test article, or a failure of test equipment, testing will be stopped and the condition of the hardware and test setup preserved.

If a test discrepancy occurs, the test will be interrupted and the discrepancy will be noted and verified. The TC and TD will ensure that all discrepancies are recorded in a PR and resolved prior to continuing the test. If a discrepancy is verified, a PR will be opened and dispositioned by the TD in accordance with LAT-SS-00971, CAL Program Quality Assurance Plan.

In conducting the failure analysis, the TD can select and re-run in any sequence, any portion of the full functional test within this procedure. Any test steps, conditions, or procedures that are not a portion of this approved test procedure that needs to be included must first be approved by the TD and QA and a PR generated before they are performed. The results are to be included or referenced in the PR and included in the as-run appendix.

If the discrepancy is dispositioned as a failure of the test article, then a MRB will be opened and dispositioned in accordance with LAT-SS-00971, CAL Program Quality Assurance Plan.

5 GENERAL TEST PROGRAM REQUIREMENTS

5.1 TEST SETUP

5.1.1 Test Location

The thermal-vacuum test will be conducted in the Thermal-Vacuum Test Laboratory (North Chamber) of the Payload Check-Out Facility, Building A-59, of the Naval Research Laboratory, Washington, D.C.

5.1.2 Test Article Configuration

The test article is the EM of the GLAST CAL Tower Module, which consists of the EM CAL Module (GLT-LLR-00-A) and the Tower Electronics Module (TEM)/TEM Power Supply (TPS) assembly, as documented in the as-built configuration list (ABCL). There are no deviations from the flight configuration.

The GLAST CAL Module in its test configuration is shown in Figure 3-1. An As-Built Configuration List (ABCL) will be generated for the test article in its test configuration.

The test article will be mounted in the upright position onto the TVAC test fixture, which simulates one bay of the LAT grid. The test fixture isolates the test article from the test chamber by means of G-10 spacers. The test will be cold-biased via a shroud cooled with liquid nitrogen. Heaters on the test fixture (four 60 W and one 100 W heater) will maintain the test temperature on the simulated grid. A cold-plate with heaters will be attached to the TEM/TPS to control its temperature.

5.1.3 Test Equipment

The following test equipment and systems will be used in the execution of this test:

- Test Chamber: South Thermal Chamber Facility / Required Cold Plates
- Test Article: GLAST CAL Module with TEM/TPS
- Test Article Support: CAL TVAC Test Fixture with Cold Plate
  CAL Hoist Fixture and Accessories
- Thermocouples: 38
- Temperature Control System: To accommodate four 60 W and one 100 W heaters
- Data Acquisition and Control PC Computer and HP 34970A Data Acquisition/Switch Unit running the LabView data acquisition software
- Residual Gas Analyzer (RGA) or TQCM
- Electrical Test Equipment Calorimeter Test Stand Data Acquisition Unit

Any substitution of the designated test equipment will require the approval of the TD and/or the TC, and QA. Such substitutions will be noted as part of the test data and submitted with the test report.

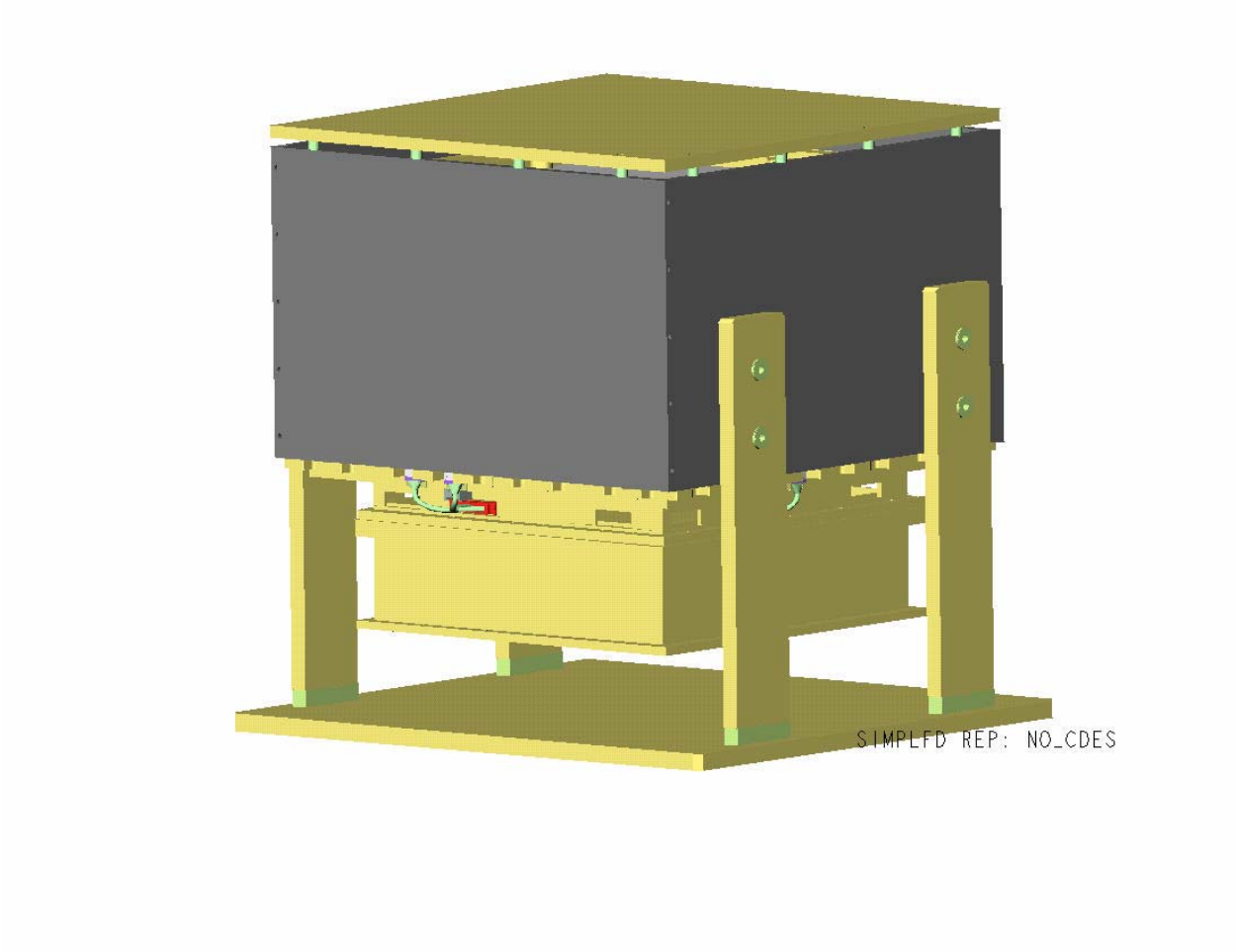


Figure 5-1 – Test Fixture with EM CAL Module

5.1.4 Handling and Control of Equipment

Handling of the EM will be under the direction of the TD and/or TC. The following equipment must be used for the proper and safe handling of the EM:

- Proper EM Grounding Strap for Electrostatic Discharge (ESD) Control
- Grounding Wrist Straps for ESD Control
- Gloves

The EM must be connected to a certified ground strap at all times. All personnel must wear gloves and ground straps when in contact with the EM.

The following equipment must be used for the proper and safe transportation of the EM as well as movement of the EM within the Vibration Facility:

- Shipping Container
- Lift Blocks
- Lift Fixture

The EM is transported to and within the Thermal-Vacuum Test Laboratory inside its shipping container. The shipping container is wheeled and is also used as a transportation dolly. The EM will be moved and positioned on the TVAC chamber platform via the facility crane. Interface between the EM and the crane is via the Lift Fixture. Lift Blocks are the attachment points between the Lift Fixture and the EM.

5.2 INSTRUMENTATION AND DATA ACQUISITION

5.2.1 Instrumentation

Test article instrumentation consists of the thermocouples as well as thermistors integral to the AFEE cards.

The EM CAL Tower Module is instrumented with 28 thermocouples. 14 additional thermocouples will be attached to the test fixture and cold plate. These additional thermocouple channels will be monitored during the test in order to control the temperature environment. All thermocouple locations are listed in Table 5-1. The locations of these thermocouples are illustrated in

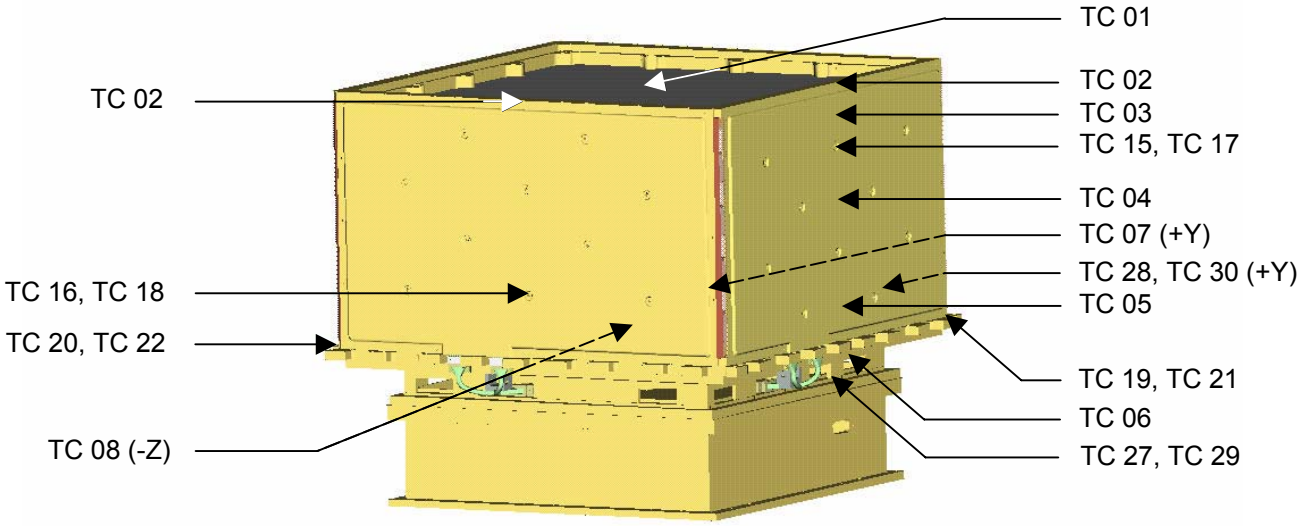
Figure 5-2 and Figure 5.3.

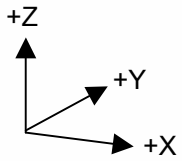
Eight thermistors, mounted two each, on the four AFEE boards are monitored separately in the housekeeping data stream of the TEM.

Test chamber instrumentation will consist of the normal thermal-vacuum chamber control instrumentation, including, but not limited to, additional thermocouples located on the cold plates and the contamination plate.

Table 5-1 – Thermocouple Locations

TC ID	Location	TC ID	Location
1	Top of Structure – Center	22	Base Plate - Close-Out Plate Joint (-X,-Y)
2	Top Frame – Median Part of +X Side	23	Composite Str - through (+X,+Y) Vent Hole
3	+X Side Panel – Median Upper Part	24	Composite Str - through (-X,-Y) Vent Hole
4	+X Side Panel – Between Inserts 4 and 5	25	Base Plate - adjacent to (+X,+Y) Vent Hole
5	+X Side Panel – Median Lower Part	26	Base Plate - adjacent to (-X,-Y) Vent Hole
6	Base Plate – Median Part of +X Side	27	Base Plate - near +X Side Stand-Off
7	Base Plate – Median Part of +Y Side	28	Base Plate - near +Y Side Stand-Off
8	Base Plate – Center	29	TEM - near +X Side Stand-Off
9	Grid – Median Part of +X Side	30	TEM - near +Y Side Stand-Off
10	Grid – Median Part of +Y Side	31	Test Fixture Wall (+X)
11	Center of CDE (Row X2, Column 5)	32	Test Fixture Wall (+X)
12	Center of CDE (Row Y1, Column 5)	33	Test Fixture Wall (+Y)
13	+Y Close-Out Plate (Row Y1, Column 5)	34	Test Fixture Wall (+Y)
14	-Y Close-Out Plate (Row Y1, Column 5)	35	Test Fixture Wall (-X)
15	Insert 2 (+X Face)	36	Test Fixture Wall (-X)
16	Insert 9 (-Y Face)	37	Test Fixture Wall (-Y)
17	+X Side Panel – Insert 2	38	Test Fixture Wall (-Y)
18	- Y Side Panel – Insert 9	39	Test Fixture Wall (+Z)
19	Close-Out Plate Joint (+X,+Y)	40	Test Fixture Wall (+Z)
20	Close-Out Plate Joint (-X,-Y)	41	TPS Cold Plate
21	Base Plate - Close-Out Plate Joint (+X,+Y)	42	TPS Cold Plate





NOT SHOWN: Internal to Structure

TC 11	CDE
TC 12	CDE
TC 13	Close-Out Plate (+Y)
TC 14	Close-Out Plate (-Y)
TC 23	Composite Structure (+X,+Y)
TC 24	Composite Structure (-X, -Y)
TC 25	Base Plate (+X,+Y)
TC 26	Base Plate (-X, -Y)

Figure 5-2 – Thermocouple Locations on the Test Article

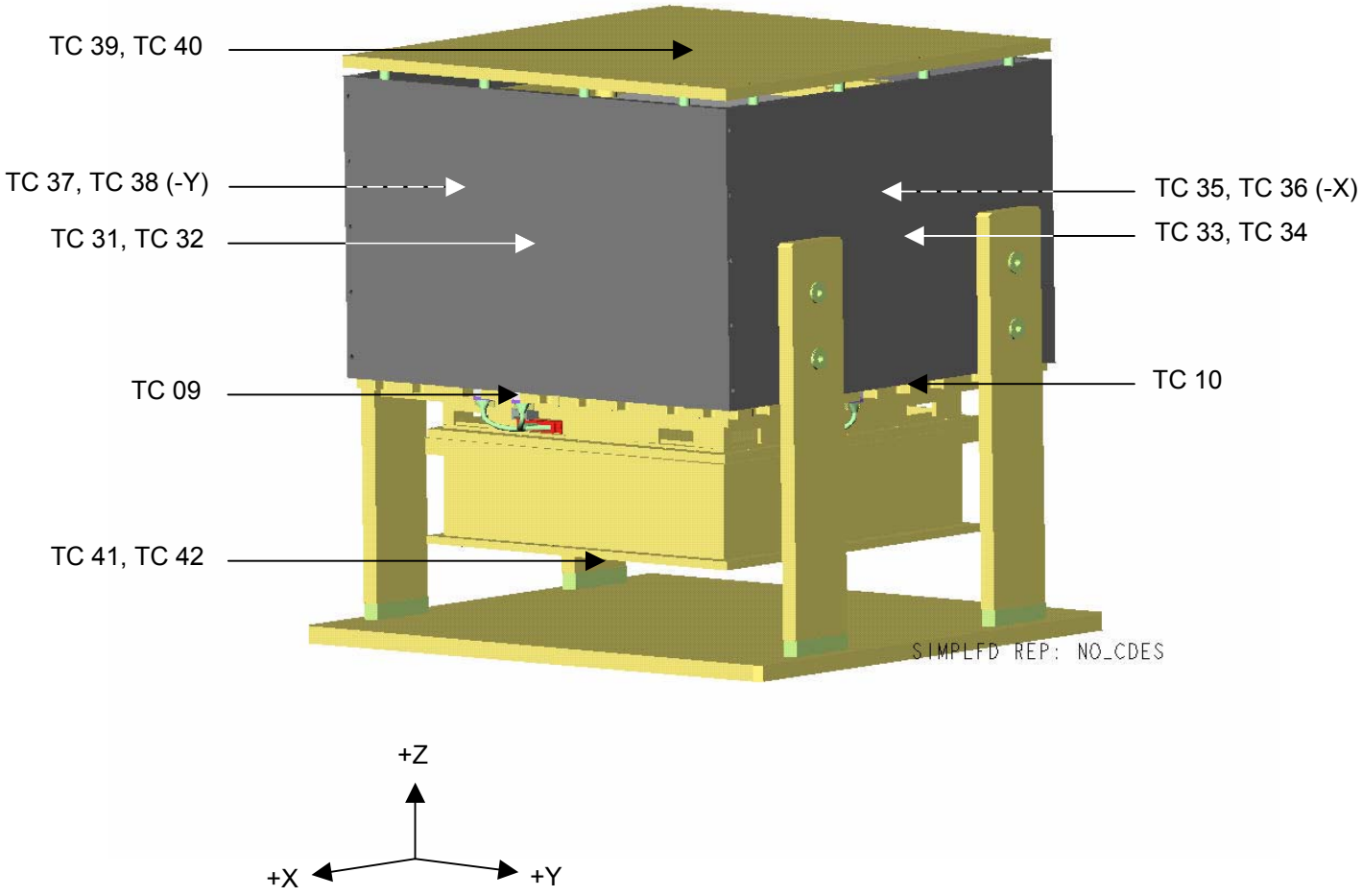


Figure 5-3 – Thermocouple Locations on the Test Fixture

5.2.2 Calibration

Standard laboratory calibration techniques will be used. Prior to testing, the thermocouples will be calibrated by comparison against a standard temperature.

5.2.3 Data Acquisition

There will be two data acquisition systems used for this test:

- Dedicated PC computer and HP 34970A Data Acquisition/Switch Unit for the TVAC chamber and test article
- Calorimeter Test Stand Data Acquisition Unit for the test article electronics

A PC computer and data acquisition/switch unit running the LabView data acquisition software will be used to collect temperature data from thermocouples on the EM CAL Tower Module, the test fixture, and the TVAC chamber (grid test fixtures and cold plates). Data will be acquired at a sampling rate of 1 sample every 5 minutes. All acquired data will be stored on the computer in ASCII format with the following sampling rates:

The Calorimeter Test Stand Data Acquisition Unit/GASU will be used to collect science and housekeeping telemetry from the TEM of the CAL Module. Temperature data from the AFEE card thermistors is imbedded in the housekeeping data stream.

5.3 VACUUM CHAMBER TEST CONDITIONS AND TOLERANCES

Prior to installation of the CAL EM, the thermal-vacuum chamber will be cleaned, by wiping all accessible surfaces of the chamber with isopropyl alcohol. Access to the chamber will then be controlled and will require suitable clothing to maintain a clean environment.

5.3.1 Environmental Conditions and Tolerances

The grid test fixture and cold plate temperatures shall be capable of maintaining any temperature between TBD

5.3.2 Outgassing

The test article and other test equipment used inside the vacuum chamber should only contain materials that are in compliance with the outgassing requirements

- Maximum Total Mass Loss (TML) of 1%
- Maximum Collected Volatile Condensible Material (CVCM) of 0.1%

5.3.3 Temperature Limits

Alarms will be set in the data acquisition to notify the Test Conductor with a warning message displayed on the terminal screen when temperatures read from the thermocouples exceed their allowable high and low limits. Thermocouple alarm limits are listed in the appendix.

5.4 DOCUMENTATION

5.4.1 Test Report

The results of the test will be documented in a separate test report, LAT-XX-XXXX) after completion of the testing. The report shall contain the as-run procedure, all test data, photographs, a complete description of the test and a description of any deviation from this procedure.

5.4.2 Test/Data Log

The Test Conductor will maintain a test log of the daily activities during the test. The test log shall contain at a minimum the date and time of each test activity, a brief description of the activity, a description of any deviation from the planned procedure, and any other information known to be significant to the test, such as photographs. Furthermore, the Test Director shall maintain a master copy of the procedure. All deviations from the procedure shall be noted as "red lines" in this master copy.

5.4.3 Photographic Coverage

Photographs will be taken of the test article, the overall test set-up, and test equipment prior to the test. Photographs will be required of any failures and items deemed significant by the Test Director or Test Conductor.

5.4.4 Test Reporting

The following is a description of the test records required at the completion of the TVAC test. These records included as part of the report and will be compliled with the As-Built records.

5.4.4.1 Data Reduction

Temperature and time history data, which is stored on the PC hard drive and printed out can easily be transferred into a spreadsheet for analysis. Similarly, the thermistor data can be extracted from housekeeping data stream stored on the GASU DVD.

The temperature data will be plotted to determine the steady state conditions and transients. This data will be used to correlate the thermal models.

5.4.4.2 Test Failure Reporting

If a test discrepancy occurs, the test shall be interrupted, the condition of the test specimen and set-up preserved, and the discrepancy verified. Any anomalies and /or failures shall be evaluated and documented in accordance to the Calorimeter Quality Assurance Plan.

5.4.4.3 Test Related Discrepancy Reports (DR)

Any DRs that are opened during the test will be contained in the as-run test results. These will be ordered as they occur and will be sequentially numbered on the discrepancy log.

5.4.5 As Run Procedure

The test director will verify that the steps of this procedure are complete during the test. The procedure will be labeled to reflect the date and time of each activity and a description of any and all failures. Signatures within the procedure will be required from either the Test Director, Test Conductor, and/or Quality Assurance to verify that specific test activities have been completed. The As-Run procedure will be included in the final test report.

5.5 HAZARDOUS CONDITIONS

5.5.1 Hazardous Environments

The hazardous environments associated with this test have been identified:

- Electrostatic Discharge (ESD)
- Electrical Power
- Gaseous Nitrogen (GN_2)
- Liquid Nitrogen (LN_2)

All personnel have access to the chamber shall be required to wear nominal clean-room attire while working inside the chamber. In addition, proper safety equipment shall be worn.

The CAL Tower Module must be connected to a certified ground wire at all times.

5.5.2 Safety Requirements

This procedure involves the use of LN_2. Therefore, proper garments, including gloves, face shield, and non-absorbent footwear shall be worn during handling of LN_2.

5.5.3 Safety Equipment

- Oxygen Monitor (for use inside the test chamber, as required)
- Ground Strap
- Gloves
- Gloves, Face Shield, and Non-Absorbent Footwear (for handling of LN_2)

5.6 PASS-FAIL CRITERIA

The GLAST CAL Module will have passed this series of testing if the following criteria are met:

- The qualification test levels are applied in accordance with this procedure.
- The GLAST CAL Module incurs no detrimental damage.
- Acquisition of data is recorded and suitable for correlation with the thermal models.
- Functional test data for the AFEE and TEM electronics are collected.
- Muon test data are collected.

6 TEST PROCEDURE

The thermal-vacuum test shall follow the temperature profile and test timeline as described in this section. Throughout the TVAC test cycle, the following testing occurs:

- Electronics Functional Testing conducted by the Electrical Subsystem Test Conductor via a test script.
- Cosmic Muon Test is conducted to verify that the Crystal Detector Elements (CDE) of the EM can still collect data. This test is initiated via a script and is conducted by the Science Subsystem Test Conductor.

6.1 TEMPERATURE PROFILE

The qualification temperature range for the CAL Tower Module shall be –30C through +50C. Temperature ramp of the CDE's shall not exceed 10 deg C/hour. Close-Out Plate temperature will be monitored since they represent the exterior temperature of the CDE stack. Vacuum shall be maintained at 1.0e-5 torr or less throughout the test.

During the first TVAC cycle, thermal balance characterization takes place. Furthermore, the bake-out function takes place during the first "hot" soak. The profile is shown in Figure 6-1.

The TVAC test environment is cold-biased by means of a grid test fixture surrounding the test fixture. Heaters on the grid test fixture and test fixture control the temperature ramp and maintain constant test temperatures. Four 60 W heaters on the X and Y sides of the test fixture as well as a 100 W heater on the +Z side of the fixture assist the grid test fixture in controlling the temperature environment of the CAL Module. An additional Cold-Plate with a heater is located on the –Z side of the TEM and controls the temperature of the TEM.

During the cold or hot soak period of each TVAC cycle, the test fixture plates representing the TKR (+Z) and the TEM (-Z) will be set according to the temperatures in Table 6-1. During Ramp-Up or Ramp-Down of temperature, Tracker and TEM temperature will be set at the final soak temperature while the X and Y Test Fixture Plates will be adjusted to maintain the 10 deg C per hour ramp (10 deg C step per hour is acceptable), not to exceed the temperatures in Table 6-1.

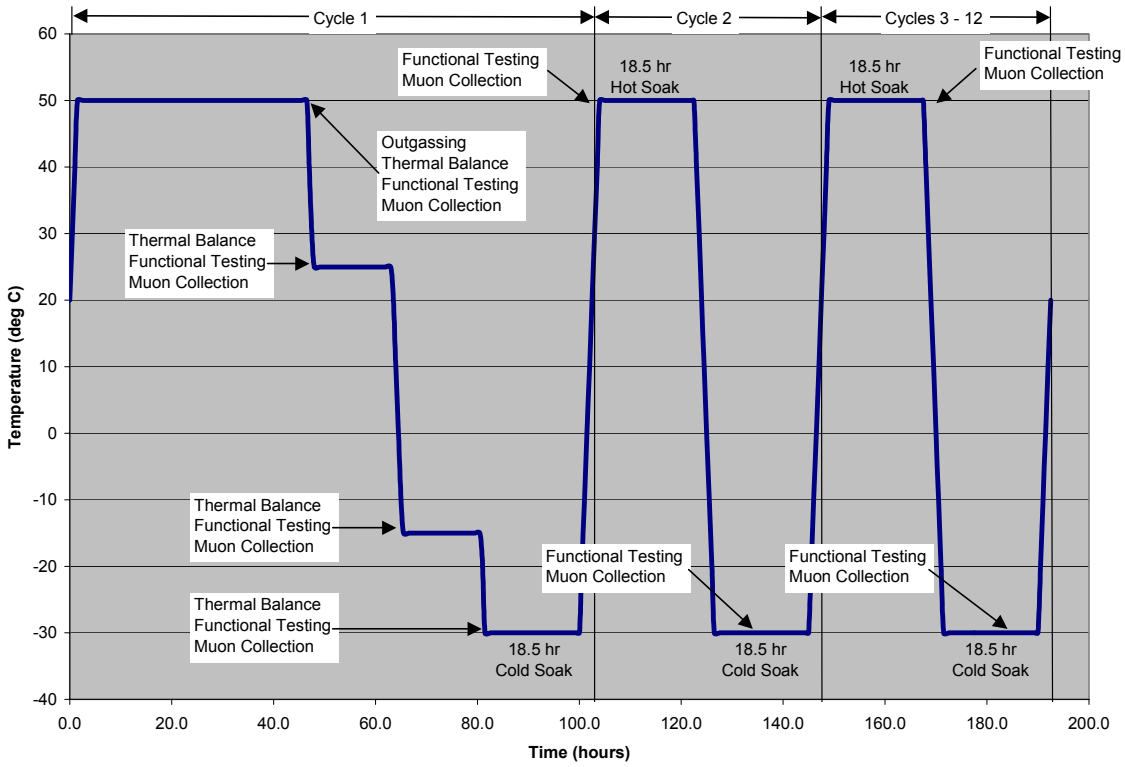


Figure 6.1 – CAL Module Qualification levels for Thermal Vacuum Testing

Table 6.1 – CAL Module Qualification levels for Thermal Vacuum Testing

TEST COMPONENT	DEFINITION	OPERATIONAL LIMITS		QUALIFICATION LIMITS	
		COLD (deg C)	HOT (deg C)	COLD (deg C)	HOT (deg C)
Test Article	CAL Module (EM)	-15	+25	-30	+50
+Z Test Fixture Plate	Tracker Module	-15	+30	-30	+50
-Z Test Fixture Plate	Tracker Electronics Module	-30	+45	-40	+50
+X Test Fixture Plate	Grid Wall (+X)	-16	+24	-31	+49
-X Test Fixture Plate	Grid Wall (-X)	-16	+24	-31	+49
+Y Test Fixture Plate	Grid Wall (+Y)	-16	+24	-31	+49
-Y Test Fixture Plate	Grid Wall (-Y)	-16	+24	-31	+49

6.2 FUNCTIONAL AND MUON TESTING DEFINITIONS

During the Thermal Vacuum Test, the CAL Tower Module shall undergo both Limited and Comprehensive Electrical Functional Testing and Muon Performance Testing. These tests, which are listed in the test timeline, are identified in the following sections.

6.2.1 Limited Functional Testing of AFEE and TEM

Limited Electrical Functional Testing (LFT) shall provide verification of selected elements of the electrical function of the AFEE and TEM electronics. The LFT shall be comprised of test procedure files as outlined in LAT-PS-1371.

6.2.2 Comprehensive Functional Testing of AFEE and TEM Electronics

Comprehensive Electrical Functional Testing (CFT) shall provide verification of the full electrical function of the AFEE and TEM electronics. The CFT shall be comprised of test procedure files as outlined in LAT-PS-1370.

6.2.3 Cosmic Muon Test

Cosmic ray muons provide patterns of energy deposition in the CAL that are analogous to the flight science data. The muon test provides a limited end-to-end functional test of science data acquisition and science performance.

6.3 TEST TIMELINE

The test timeline for the first two test cycles are given below. Although these two cycles are dedicated for thermal balance measurements, functional testing and muon measurements will take place. The remainder of the twelve cycles is identical to the second test cycle. Deviations from this test timeline shall be permitted at the discretion of the Test Director. The time, activity, and purpose of each deviation shall be noted in the Test Log.

Day	Elapsed Time	Activity
Day 0	00:00 hr	Bag CAL Tower Module and move to Building A59
	00:00 hr	Remove from bag and install CAL in TVAC Chamber
	00:00 hr	Perform Limited Functional Test (LAT-PS-01371)
	00:00 hr	Initiate Vacuum Pump-Down and maintain at high vacuum (1e-5 torr or less)
	00:00 hr	Power up CAL
	00:00 hr	Perform Comprehensive Functional Test (LAT-PS-01370)
	00:00 hr	Begin Cosmic Muon Collection
	00:00 hr	Power down CAL
	00:00 hr	Begin Data Acquisition for TVAC Test Power up PC/HP 34970A Data Acquisition/Switch Unit Initialize the LabView Software per instructions in Appendix A. Turn on grid test fixture heaters
	00:00 hr	Begin Heating Cycle. Set grid test fixture temperature to –20C. Adjust grid test fixture power as necessary to maintain temperature ramp of the crystals at 20 deg C/hour.
	00:30 hr	Set grid test fixture temperature to +30C. Adjust grid test fixture power as necessary to maintain temperature ramp of the crystals at 20 deg C/hour.
	01:00 hr	Set grid test fixture temperature to +40C. Adjust grid test fixture power as necessary to maintain temperature ramp of the crystals at 20 deg C/hour.
	01:30 hr	Set grid test fixture temperature to +49C. Adjust grid test fixture power as necessary to maintain the +50C temperature at the CAL Module for the Qual Temperature Hot Soak and Thermal Balance.
Day 1	01:30 hr	Outgas Period
	38:30 hr	Begin 8-hour window for Comprehensive Functional Test (LAT-PS-01370) at High Temperature
	38:30 hr	Begin Cosmic Muon Collection

Day	Elapsed Time	Activity
	46:30 hr	Begin Cooling Cycle. Set grid test fixture temperature to +40C. Adjust grid test fixture power as necessary to maintain temperature ramp of the crystals at 20 deg C/hour.
	47:00 hr	Set grid test fixture temperature to +30C. Adjust grid test fixture power as necessary to maintain temperature ramp of the crystals at 20 deg C/hour.
	47:30 hr	Set grid test fixture temperature to +25C. Adjust grid test fixture power as necessary to maintain the +25C temperature at the CAL Module for the Nominal Hot Operating Temperature Thermal Balance.
Day 2	60:00 hr	Begin 3-hour window for Limited Functional Test (LAT-PS-01371) at Nominal Hot Operating Temperature.
	63:00 hr	Begin Cooling Cycle. Set grid test fixture temperature to +20C. Adjust grid test fixture power as necessary to maintain temperature ramp of the crystals at 20 deg C/hour.
	65:30 hr	Set grid test fixture temperature to –15C. Adjust grid test fixture power as necessary to maintain the –15C temperature at the CAL Module for the Nominal Cold Operating Temperature Thermal Balance.
Day 3	72:30 hr	Begin 3-hour window for Limited Functional Test (LAT-PS-01371) at Nominal Cold Operating Temperature.
	80:30 hr	Begin Cooling Cycle. Set grid test fixture temperature to -20C. Adjust grid test fixture power as necessary to maintain temperature ramp of the crystals at 20 deg C/hour.
	81:30 hr	Set grid test fixture temperature to -30C. Adjust grid test fixture power as necessary to maintain the -30C temperature at the CAL Module for the Qual Temperature Cold Soak and Thermal Balance.
	92:00 hr	Begin 8-hour window for Comprehensive Functional Test (LAT-PS-01370) at Low Qualification Temperature
	92:00 hr	Begin Cosmic Muon Collection
Day 4	100:30 hr	Begin Heating Cycle. Set grid test fixture temperature to –20C. Adjust grid test fixture power as necessary to maintain temperature ramp of the crystals at 20 deg C/hour.
	101:00 hr	Set grid test fixture temperature to –10C. Adjust grid test fixture power as necessary to maintain temperature ramp of the crystals at 20 deg C/hour.
	101:30 hr	Set grid test fixture temperature to 0C. Adjust grid test fixture power as necessary to maintain temperature ramp of the crystals at 20 deg C/hour.
	102:00 hr	Set grid test fixture temperature to +10C. Adjust grid test fixture power as necessary to maintain temperature ramp of the crystals at 20 deg C/hour.
	102:30 hr	Set grid test fixture temperature to +20C. Adjust grid test fixture power as necessary to maintain temperature ramp of the crystals at 20 deg C/hour.
	103:00 hr	Set grid test fixture temperature to +30C. Adjust grid test fixture power as necessary to maintain temperature ramp of the crystals at 20 deg C/hour.

Day	Elapsed Time	Activity
	103:30 hr	Set grid test fixture temperature to +40C. Adjust grid test fixture power as necessary to maintain temperature ramp of the crystals at 20 deg C/hour.
	104:00 hr	Set grid test fixture temperature to +49C. Adjust grid test fixture power as necessary to maintain the +30C temperature at the CAL Module for the Qualification Temperature Hot Soak.
	114:30 hr	Begin 8-hour window for Comprehensive Functional Test (LAT-PS-01370) at High Temperature
	114:30 hr	Begin Cosmic Muon Collection
Day 5	123:00 hr	Begin Cooling Cycle. Set grid test fixture temperature to +40C. Adjust grid test fixture power as necessary to maintain temperature ramp of the crystals at 20 deg C/hour.
	123:30 hr	Set grid test fixture temperature to +30C. Adjust grid test fixture power as necessary to maintain temperature ramp of the crystals at 20 deg C/hour.
	124:00 hr	Set grid test fixture temperature to +20C. Adjust grid test fixture power as necessary to maintain temperature ramp of the crystals at 20 deg C/hour.
	124:30 hr	Set grid test fixture temperature to +10C. Adjust grid test fixture power as necessary to maintain temperature ramp of the crystals at 20 deg C/hour.
	125:00 hr	Set grid test fixture temperature to 0C. Adjust grid test fixture power as necessary to maintain temperature ramp of the crystals at 20 deg C/hour.
	125:30 hr	Set grid test fixture temperature to –10C. Adjust grid test fixture power as necessary to maintain temperature ramp of the crystals at 20 deg C/hour.
	126:00 hr	Set grid test fixture temperature to –20C. Adjust grid test fixture power as necessary to maintain temperature ramp of the crystals at 20 deg C/hour.
	126:30 hr	Set grid test fixture temperature to –31C. Adjust grid test fixture power as necessary to maintain the –30C temperature at the CAL Module for the Qualification Temperature Cold Soak.
	137:00 hr	Begin 8-hour window for Comprehensive Functional Test (LAT-PS-01370) at Low Qualification Temperature
	137:00 hr	Begin Cosmic Muon Collection
Day 6	145:30 hr	Begin Heating Cycle. Set grid test fixture temperature to –20C. Adjust grid test fixture power as necessary to maintain temperature ramp of the crystals at 20 deg C/hour.
	146:00 hr	Set grid test fixture temperature to –10C. Adjust grid test fixture power as necessary to maintain temperature ramp of the crystals at 20 deg C/hour.
	146:30 hr	Set grid test fixture temperature to 0C. Adjust grid test fixture power as necessary to maintain temperature ramp of the crystals at 20 deg C/hour.
	147:00 hr	Set grid test fixture temperature to +10C. Adjust grid test fixture power as necessary to maintain temperature ramp of the crystals at 20 deg C/hour.
	147:30 hr	Set grid test fixture temperature to +20C. Adjust grid test fixture power as necessary to maintain temperature ramp of the crystals at 20 deg C/hour.